

SHORT COMMUNICATIONS

RESPONSE TO KIRKLEY

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Smith (1980, 1985), and later Smith et al. (1986), presented the hypothesis that some raptors (Swainson's Hawks, *Buteo swainsoni*, and Broad-winged Hawks, *Buteo platypterus*, in particular) might fast during portions of their soaring migration, and we considered the question of whether these birds could store sufficient energy to fuel long-distance soaring. Kirkley has reconsidered several of the arguments presented by Smith et al. (1986) and concludes that fasting is unlikely. These reconsiderations involve questions of energetics, water balance, and ecology. Each of these points deserves some discussion.

Smith et al. (1986) noted that no feces were found under trees where mass roosts of migrant hawks spent the night. Kirkley suggests that perhaps the hawks feed in early morning and completely eliminate their feces prior to roosting. This seems a reasonable and testable hypothesis. It might be substantiated, for example, by observations of early morning feeding by large flocks of migrant Swainson's or Broad-winged Hawks. At present, we are unaware of reports of such feeding bouts.

The energetics model presented by Smith et al. (1986) examined the mass of fat that would be required to fuel flights of different durations. What would be the migration range based on a reasonable mass of stored fat? We concluded that "... migration by the hawks without feeding from the southern U.S. to northern South America would require deposition of fat amounting to 20-25% of lean body mass. Although such fat deposition has not been recorded for raptors, this is within the range commonly measured in migratory birds of other taxa (and so) our calculations suggest that a long-distance fasting migration is physiologically reasonable." According to the model, deposition of this mass of fat would fuel a migrating Swainson's Hawk for approximately 2.5 wk and 4000-4500 km. Kirkley sets up something of a straw man in his argument, choosing to focus on flights of longer distance (9000 km) and duration (up to six weeks). Although we calculated that such a prolonged fasting migration would require greater than 50% mass gain as premigratory fat, we never suggested that the hawks actually accomplish this level of

fattening. We might also note that measurements of pre-migratory fat deposition in large birds with migratory strategies like Swainson's and Broad-winged Hawks are simply unavailable.

Kirkley also argues that negative water balance would preclude a fasting migration. It is generally acknowledged that metabolic water will rarely match evaporative water losses in birds, and only a few small species, mostly desert-adapted birds, can survive on a dry diet (Bartholomew 1972). One might therefore expect a fasting hawk to lose body mass from a water deficit. Nevertheless, this argument does not preclude a prolonged fast. First, several large birds, including species of geese and penguins, do endure prolonged fasts (Cherel et al. 1988). Second, Kirkley has based his calculations on rates of evaporation measured on normally hydrated birds under conditions of low humidity in the laboratory. Evaporative water loss is reduced in high humidity environments (Lasiewski et al. 1966, Webster and King 1987), and can also be physiologically modified in water-stressed birds (Arad et al. 1987). Thus, the ambient and physiological conditions during migration may affect rates of evaporation. Actual measures of physiological condition of migrating hawks, such as permeability of the skin to water vapor, plasma and urine osmotic concentrations, or plasma concentrations of anti-diuretic hormone, might elucidate the physiological condition of these birds with respect to water balance.

Finally, Kirkley argues that it just doesn't make sense for the birds to fast as they cross the insect-rich tropics and sub-tropics, and again he argues in terms of a six week, 9000 km flight. In contrast, we have suggested that it might be difficult for an individual bird to procure a substantial meal among a dense crowd of conspecifics. First, Broad-winged Hawks are not highly insectivorous. Second, the migratory passages of Broad-winged and Swainson's Hawks are quite highly circumscribed, suggesting that individuals do not drop out to feed for any extended period. It is not obvious that insects, or other prey, would be easily available to dense concentrations of these large birds, especially in forested regions. Finally,

